


Utility of Specialized Imaging for Diagnosis of Chronic Wrist Pain

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J Wrist Surg 2019;8:497–502.

Abstract

Background Patients with chronic wrist pain often undergo imaging (such as magnetic resonance imaging [MRI], computed tomography [CT], or ultrasound [US]) prior to specialist assessment.

Questions Is specialized wrist imaging performed prior to expert consultation necessary? Are there demographic differences between patients who do or do not receive preconsultation imaging?

Patients and Methods A total of 115 patients referred to a tertiary hand center for chronic wrist pain and assessed by a hand surgeon were included. At initial consultation, surgeons were blinded to referral information and previous imaging results. The specialist performed a history, physical examination and reviewed X-rays. They established a clinical diagnosis and whether any additional investigations were needed. Prior MRI, CT, and/or US results were then reviewed and the specialists' clinical diagnosis was compared with the blinded referral diagnosis. Preconsultation imaging was categorized as having no value for diagnosis/management, some value, or high value.

Results A total of 82 patients had imaging prior to specialist referral (69 MRIs, 11 CTs, and 16 ultrasounds). The majority of additional imaging (73%) was classified as unnecessary, including 77% of the MRIs and 100% of the ultrasounds. Of all the investigations performed, two CT scans were labeled highly valuable clinical aids. Older patients and those with radial-sided pain were less likely to receive preconsultation imaging. Six patients required further imaging after consultation.

Conclusion Clinical assessment and X-rays are typically sufficient for a hand specialist to diagnose and manage chronic wrist pain and few patients require additional imaging.

Level of Evidence This is a Level III study.

Keywords

- ▶ computed tomography
- ▶ imaging
- ▶ magnetic resonance imaging
- ▶ ultrasound
- ▶ wrist pain
- ▶ diagnostic tests

Chronic wrist pain is a complex problem and is a common chief complaint in many sports medicine and primary care clinics. Wrist pain has numerous causes, and it can be difficult to elucidate the underlying issues without referral to a hand or wrist specialist. Patients with wrist pain often undergo radiographic evaluation as well as further special-

ized testing with magnetic resonance imaging (MRI), computed tomography (CT) scan, or ultrasound (US), to investigate underlying causes prior to consultant referral.¹ It is unclear whether or not these pre-emptive specialized investigations have an impact on final diagnosis or management. Many common diagnoses based on MRI results,

received

November 14, 2018

accepted

August 6, 2019

published online

September 24, 2019

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Tel: +1(212) 584-4662.

DOI <https://doi.org/10.1055/s-0039-1697022>.
ISSN 2163-3916.

such as ganglion cysts, triangular fibrocartilage complex (TFCC) pathology, and advanced collapse osteoarthritis can be determined by clinical assessment and X-rays.

Although imaging studies may provide a noninvasive means to investigate chronic wrist pain, unnecessary investigations can result in false positive and false negative diagnoses. Superfluous scans may be associated with substantial direct and indirect costs, and may prolong time to treatment. Michelotti et al showed that indiscriminate use of MRI was associated with an impact cost up to \$15,565 per wrist scan.² Recent US investigations have estimated the global cost burden of imaging overutilization at over \$17 billion annually.³ Overutilization has previously been highlighted in the chronic back pain population, with MRI being routinely ordered without clear guidance on indications.⁴ To mitigate this potential misuse of resources, health services researchers have taken the necessary steps to develop guidelines for MRI evaluation of back pain for referring physicians.⁵ This study represents the initial step of a similar initiative for imaging utilization in chronic wrist pain. Currently, there are no well-accepted guidelines to direct appropriate use of MRI, CT, and US as diagnostic tests for chronic wrist pain. Further, a knowledge gap exists surrounding the potential overutilization of these modalities for wrist pain evaluation. The American College of Radiology have developed Appropriateness criteria; however, these are not routinely used and have limitations.^{6,7} Patients must be placed into 1 of 12 different groups, which can make the algorithm difficult to follow. Without clear recommendations, referring physicians may be unnecessarily ordering diagnostic imaging in an attempt to establish a diagnosis prior to considering specialist referral.

The primary purpose of this study was to examine: (1) the frequency of specialized wrist imaging (MRI, CT scan, or US) prior to specialist consultation in patients with chronic wrist pain; and (2) the utility of these investigations during the specialist consultation. The secondary purpose was to examine the demographic differences between patients who did versus did not undergo preconsultation specialized wrist imaging for chronic wrist pain.

Patients and Methods

Patients and Study Design

The cross-sectional study was conducted at a single high-volume tertiary level hand and wrist center. Research ethics approval was obtained by the institutional review board. A total of 115 consecutive patients referred with chronic wrist pain (>6 weeks symptom duration) between January 2016 and October 2016 were assessed by one of the two fellowship-trained hand and wrist surgeons. Direct emergency room referrals were excluded and there was no difference in the type of referrals sent to each specialist.

Data Collected

At the initial consultation, patient demographic (age, sex, and residence location), work-related complaint/injury, referral source (specialty and date), referring physician chronic

wrist pain diagnosis, and preconsultation imaging data (diagnosis and additional findings) were collected. At the initial visit, the hand specialist recorded the history and physical examination findings, and reviewed X-rays that were available for all cases. Based on this assessment, they established a diagnosis and treatment plan, and recorded the need for further specialized imaging. The hand specialists were blinded to the referring source, the referring diagnosis, and any specialized imaging.

Classification of Preconsultation Imaging

Upon completion of the clinical encounter, the hand specialist reviewed the preconsultation imaging, which was then categorized as: (1) noncontributory to the diagnosis or management; (2) had some value; or (3) had high value. "Noncontributory" preconsultation imaging studies offered no additional information beyond the clinical assessment and plain X-rays, if they were not available for review, or if they detected findings which did not clinically correlate to the described pain (false positives). Preconsultation imaging offered "some value" when additional information beyond examination or plain films were provided, but did not necessarily affect treatment or diagnosis. "High value" preconsultation imaging provided essential information for diagnosis or treatment plan formulation.

Statistical Analysis

Summary statistics were generated for the study cohort. Categorical factors were assessed using frequencies and percentages. Bivariate comparisons were made between the patients based on the presence of preconsultation imaging. Categorical factors were compared between the groups using the Chi-square test or the Fisher's Exact test, as appropriate. Continuous variables were compared using two sample *t*-tests. *p*-Values less than 0.05 were considered statistically significant.

Results

Primary Objective

Patient demographics are presented in ►Table 1. Of the 115 patients, 82 (71%) had preconsultation imaging other than plain X-ray ordered by the referring physician. A total of 96 investigations were performed, including MRI (*n* = 69), CT (*n* = 11) and US (*n* = 16) (►Fig. 1). Thirteen patients had more than one additional imaging modality performed.

Hand specialists classified 77% of the preconsultation MRIs as "noncontributory" to final diagnosis or management, 23% of "some value," and 0% as "high value." False positives were detected on MRI in 51% of the participants (*n* = 33), most commonly an incidental finding of a possible TFCC tear, when the patient had no complaints of ulnar-sided wrist pain. In select cases (*n* = 4), regions that elicited pain on examination had no corresponding findings on MRI.

Of the 11 CT scans performed, one was classified as "noncontributory," 73% classified as "some value," and 18% as "high value." CT provided better imaging of the carpal bones compared with plain radiographs and this did impact

Table 1 Demographics for all subjects

Demographics	Total sample <i>n</i> = 115	Patients with additional imaging (<i>n</i> = 82)	Patients without additional imaging (<i>n</i> = 33)	<i>p</i> -Value comparing those with and without additional imaging
Age, years (Mean ± SD)	44 ± 17	40 ± 16	53 ± 17	<0.01
Sex, male (<i>n</i> [%])	61 (53)	41 (50)	20 (61)	0.41
Referral to consultation date, days (Mean ± SD)	173 ± 226	162 ± 183	209 ± 198	0.13
Work-related (<i>n</i> [%])	8 (7.0)	7 (8.5)	1 (3.0)	0.44
Address				0.52
Urban address (<i>n</i> [%])	65 (57)	44 (54)	21 (64)	
Rural address (<i>n</i> [%])	43 (37)	32 (39)	11 (33)	
Unknown (<i>n</i> [%])	7 (6.1)	6 (7.3)	1 (3.0)	
Hand dominance				1.00
Right (<i>n</i> [%])	95 (83)	68 (83)	27 (82)	
Left (<i>n</i> [%])	10 (8.7)	7 (8.5)	3 (9.1)	
Unknown (<i>n</i> [%])	10 (8.7)	7 (8.5)	3 (9.1)	
Referral and final diagnoses agreement				0.82
Yes (<i>n</i> [%])	34 (30)	24 (29)	10 (30)	
No (<i>n</i> [%])	52 (45)	35 (43)	17 (52)	
Partially (<i>n</i> [%])	29 (25)	23 (28)	6 (18)	
Pain location				<0.01
Radial (<i>n</i> [%])	47 (41)	29 (35)	22 (67)	
Ulnar (<i>n</i> [%])	46 (40)	40 (49)	6 (18)	
Both (<i>n</i> [%])	4 (3.5)	2 (2.4)	2 (6.0)	
Other (<i>n</i> [%])	18 (16)	13 (16)	5 (15)	
Additional imaging ordered	6 (5.2)	3 (3.7)	3 (9.1)	0.35
MRI	1 (0.87)	0	1 (3.0)	0.29
CT	4 (3.5)	2 (2.4)	2 (6.1)	0.58
US	1 (0.87)	1 (1.2)	0	1.00
Referring specialty				
Family/General practice	48 (42)	34 (41)	14 (42)	1.00
Orthopaedic surgery	29 (25)	16 (20)	13 (39)	0.03
Plastic surgery	10 (8.7)	9 (11)	1 (3.0)	0.28
Hand surgery	4 (3.5)	3 (3.7)	1 (3.0)	1.00
Other	18 (16)	15 (18)	3 (9.1)	0.27
Unknown	6 (5.2)	5 (6.1)	1 (3.0)	0.67

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; US, ultrasound.

Note 1: Data presented as mean ± standard deviation (SD) where appropriate, or frequencies with percentages reported in brackets.

Note 2: Bold values indicate a statistically significant difference at $p < 0.05$.

clinical decision making. For example, CT scan helped to better characterize the complexity of scaphoid nonunion and aid in preoperative planning. Of all the additional imaging performed, only two CT scans were classified as highly valuable aids in clinical management.

All preconsultation US imagings were classified as “non-contributory.” Similar to MRI, there were a high number of incidental findings, as well as several diagnoses missed by

US. The majority of specialized imaging ordered prior to specialist consultation (72%) was classified as unnecessary. Only six patients required additional imaging at the request of the hand specialist after consultation and routine X-rays. These additional imaging studies included four CT scans, one US, and one MRI. For half of these patients ($n = 3$), a diagnosis was established clinically and imaging ordered primarily to guide treatment.

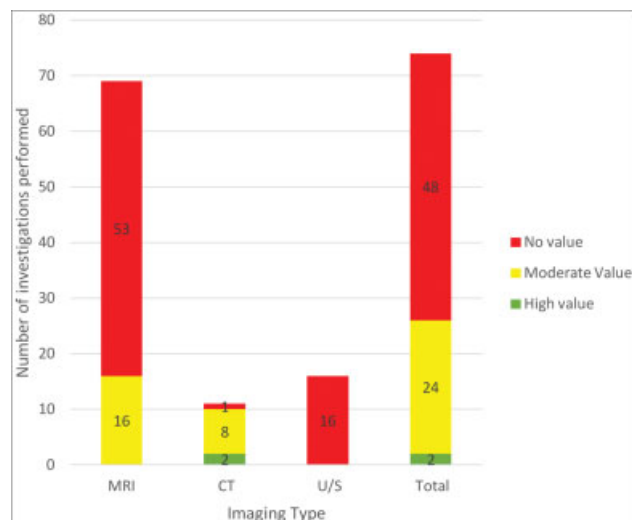


Fig. 1 A total of 82 of the 115 patients (71%) referred with chronic wrist pain had 96 additional imaging studies performed prior to specialist consultation. Imaging type and value categories for establishing diagnosis or treatment are outlined.

Secondary Objective

Patients who were older, had radial-sided wrist pain, or an orthopaedic surgeon as the referring specialist were significantly less likely to receive preconsultation imaging ($p < 0.01$). Sex, handedness, or if the injury was work related were not significantly associated with preconsultation imaging.

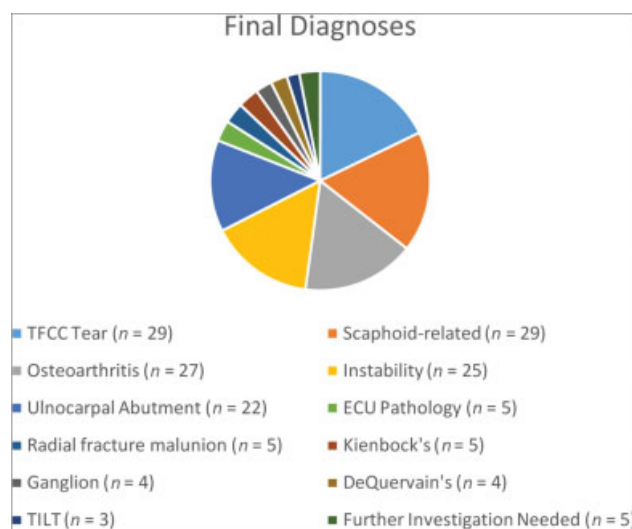


Fig. 2 The wrist pain diagnoses established by the staff surgeons at initial consultation are categorized and outlined. Diagnostic categories with limited representation ($n \leq 2$) were excluded from the figure. Scaphoid-related pathology included scaphoid nonunion ($n = 7$), scapholunate ligament injury ($n = 18$), and scaphoid impingement syndromes ($n = 4$). Osteoarthritis included scaphoid lunette advanced collapse ($n = 9$), scaphoid nonunion advanced collapse ($n = 5$), first carpometacarpal joint arthritis ($n = 4$), distal radioulnar joint (DRUJ) arthritis ($n = 4$), and scaphotrapezotrapezoidal arthritis ($n = 3$). Midcarpal instability ($n = 10$), DRUJ instability ($n = 9$) and hypermobility ($n = 6$) were all broadly categorized as "instability." Extensor carpi ulnaris pathology included tendonitis ($n = 2$), tears ($n = 2$), and instability ($n = 1$).

The final diagnoses established at initial consultation are outlined in **Fig. 2**. Five patients required further assessment to establish a definitive diagnosis: three patients were referred for imaging, one for arthroscopy, and one patient presented with resolution of symptoms and no clinical findings and was recommended for reassessment as needed.

Discussion

A comprehensive history, physical examination, and plain radiographs were all that were required to evaluate and treat chronic wrist pain in the majority of patients. Preconsultation specialized imaging may have a role in assessment, but there are indications, strengths, and weaknesses of each modality that require appropriate recognition by the ordering physician.⁸ In our study, the majority of imaging done prior to the specialist consultation was noncontributory to diagnosis or management. Of the 96 investigations performed on 115 patients, two (2%) were deemed to be highly valuable. The MRI and US investigations rarely provided any additional value, while the majority of CT scans were somewhat valuable as they provided more information on osseous pathology compared with routine radiographs.

Prior studies have demonstrated limited utility of MRI in chronic wrist pain. MRI has been a useful tool to identify central and radial TFCC tears, but ulnar-sided tears are routinely missed.^{9,10} Studies on asymptomatic wrists have demonstrated a high rate of incidental TFCC findings, extensor carpi ulnaris pathology, and ganglia.¹¹⁻¹³ Multiple conditions, including ligament tears and Preiser disease, could be better imaged with gadolinium-enhanced MR arthrograms rather than routine MR alone.^{9,14} MRI can be useful to detect occult carpal bone fractures, but treatment may be unnecessary if they are not visible on CT or radiographs.^{9,15} False negative MRI findings were often associated with pathology when wrist arthroscopy was performed.^{16,17}

Overuse of MRI for chronic wrist pain has previously been documented. When nonhand surgeons ordered an MRI to evaluate wrist injury, only 18% impacted treatment and were associated with higher cost.² MRI studies that do not impact management are costly, time-consuming, and can delay definitive treatment. Preconsultation MRI can increase patient anxiety, particularly with incidental nonsymptomatic pathology. Routine use of specialized imaging may perpetuate the belief among patients that investigations are incomplete without an MRI and lead to unnecessary imaging.

CT scanning can be helpful in identifying occult, non-displaced, or intraarticular carpal bone fractures.¹⁹⁻²¹ Displaced scaphoid fractures were better detected with CT compared with X-ray.²² Preoperative CT scans in suspected scaphoid nonunions have been shown to accurately identify avascular necrosis and predict fracture union.¹⁸ Carpal bone fractures in young adults were better detected on CT versus MRI, although CT was more likely to miss ligamentous injuries.²³ CT allows for advanced delineation of the osseous anatomy compared with other imaging modalities, and has been shown in our study to be a useful investigation in select patients with chronic wrist pain.

US can provide a noninvasive, low cost, radiation-free, and widely accessible alternative to MRI or CT. There are several associated challenges, however.²⁴ It is useful for foreign body detection and tendon rupture, but has low utility for fractures and TFCC tears.¹⁹ The appearance of the extensor retinaculum on US can mimic tenosynovitis, and normal hypoechoic clefts can be visualized in multiple tendons which are incorrectly interpreted as tears.^{24,25} Anatomic variations, such as extensor digitorum brevis manus or an inverted palmaris longus, may be interpreted as soft tissue masses.^{24,26,27} Suspected ganglion cysts are often imaged with US, but this may be unnecessary prior to treatment if history and physical examination are consistent.²⁸ In our study, US was not a useful adjunct in any case of chronic wrist pain.

Three demographic factors (older age, radial sided pain, and referral by orthopaedics) resulted in less preconsultation imaging. Older patients tended to have arthropathies visible on X-ray, eliminating the need for further investigations. A larger differential for ulnar sided wrist pain may have contributed to the increased imaging rate.

This cross-sectional, observational study has the limitation of a small sample size, yet this cohort was adequate to demonstrate the frequency of additional imaging prior to tertiary care referral. The main limitation of the study is performance bias introduced by the individual practice and preferences of the hand surgeons evaluating patients in our study. Bias may be introduced based on geographic location and access to imaging resources and the influence that this may have on surgeon's preferences. To improve the generalizability of the study, further investigation in other centers with geographic diversity would be prudent. The methodology introduces the possibility of selection and reviewer bias and depends on reported accuracy to avoid diagnostic errors. In our study, the majority of patients were assessed by one hand surgeon and there was insufficient power to perform subanalyses comparing surgeons. This study evaluated the use of specialized wrist imaging that was performed prior to hand specialist consultation and we identified a priori variables related to demographics and referring specialty to evaluate in this study. There are numerous variables that may be associated with the diagnosis of wrist pathologies and outcomes and will be evaluated in future studies.

Clinical assessment and radiographs were sufficient to determine the chronic wrist pain diagnosis in 93% of the cases. A small subset of patients may require additional specialized imaging. The results of this study suggest that referring providers generally do not need to order MRI, CT, or US prior to consulting a wrist specialist. Specialized imaging has the ability to introduce both false positive and negative results. Expert assessment has substantial value and may be more cost-effective if it reduces the need for unnecessary diagnostic imaging. This has the potential to decrease technician and equipment costs, and the fees associated with radiology consultation and reports. There are direct and indirect patient costs involved with each investigation, such as requiring additional time off work, or anxiety created by false positive results.

Future studies and education can be directed at referring physicians to identify a means for efficiently guiding the use of preconsultation imaging. The ultimate goal is to decrease the utilization of these expensive and often unnecessary resources, which will ultimately decrease costs to patients, insurers, third party payers, and the health system. This will provide a decreased demand for unnecessary imaging and can ensure more timely access to this resource when indicated.

Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

This study has obtained ethics approval from the institutional review board.

Conflict of Interest

None declared.

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